FLIGHT SOFTWARE USERS MANUAL FOR THE THERMAL ION DYNAMICS EXPERIMENT (TIDE) INSTRUMENT

SwRI Project 15-3348

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1.0 INTRODUCTION

This document is the Flight Software Users Manual for the operation of the Thermal Ion Dynamics Experiment (TIDE) developed by Southwest Research Institute (SwRI) for the Marshall Space Flight Center (MSFC). This document was developed to describe the operation of TIDE from a on-orbit science operations point-of-view. The document will emphasize the science modes of TIDE; how to place TIDE in a desired science mode and what the TIDE telemtry response should be. This document will heavily reference the TIDE Flight Software Requirements Document, 3348-FSRD-01. No attempts will be made to duplicate the information contained in document 3348-FSRD-01.

2.0 APPLICABLE DOCUMENTS AND STANDARDS

The following documents and standards form a part of this procedure to the extent specified in the body of this procedure. In cases where no date is shown for a document, the latest issue shall be assumed. In the event of a conflict between the contents of this procedure and the contents of one or more of the referenced documents or procedures, this procedure shall take precedence.

<u>SwRI Documents</u>

3348-SPAIP-01 Software Performance Assurance Implementation Plan for TIDE

3348-FSRD-01 Flight Software Requirements Document for TIDE

<u>Lockheed Martin Documents</u>

Polar Command and Telemetry Handbook Rev. 3.1 Issue Date: Jan. 15, 1995

3.0 DETAILED DESCRIPTION

3.1 <u>Initialization</u>

Upon application of power to TIDE, the Instrument Mode Processor (IMP) and Data Processor (DP) perform a power-on-reset that initializes the microprocessors and causes the microprocessors to execute application software beginning at memory address 0. The IMP commands the DP to enter a hard reset. The IMP enters into a 30 second wait. This period is a window of opportunity to execute the "BOOTSRAP 2" command, if the user desires to enter into Debug Mode (See section xx.x) in a diagnostic situation. The IMP then performs software initialization, hardware tests, and moves the application code to RAM. The IMP outputs a series of codes in telemetry that informs the user what operation it is performing. There is no attempt to synchronize the output of the initialization codes to the spacecraft telemetry timing. During the course of the initialization, the IMP releases the DP by commanding reset off. The DP performs the same basic functions as the IMP. Table 3.1 lists the initialization codes and its function.

Table 3.1 IMP Initialization Codes

Initialization Code	Initialization Function
Normal Startup	
1	30 second wait for possible command debug flag.
2	stack RAM test, interrupt table initialization
3	full RAM test
4	ROM checksum calculation and verification
5	Load part 1 of program code from ROM to RAM and verify
6	Load part 2 of program code from ROM to RAM and verify
7	Not used
8	Jump to main program in RAM
Normal Initialization	
5	Shared RAM test
6	Setup of MLUT data and MLUT hardware test
7	Install interrupts
8	Activate interrupts, DP released and wait for DP synchronization (waits up to 3 minutes for DP to respond)
9	Waiting for telemetry major frame sync, once synced telemetry data output initiated
	Science data fill pattern output
2	Turn on minor frame and telemetry interrupt
3	Initialize energy sweep table

Initialization Code	Initialization Function
4	Direct event memory RAM test
5	Selects MLUT 0
6	Hardware latch initializations: Sample clock, phase shift, remap PROMs, power supply DACs, select active energy sweep table
7	Set DP health, enable all interrupts and start acquisition system
0	Begin normal operations

Notes: 1) During the normal startup portion of the initialization, the IMP makes no attempt to synchronize the output of the codes to the telemetry shift register. There may be occasions when the IMP outputs a code to the hardware shift register while the spacecraft is shifting the data out. This operation will result in a erroneous code to be output. This is a normal, explained occurence and does not compromise the TIDE operations.

2) Some of the operations during initialization are faster than the sampling rate of telemetry pick-up, and codes could be missed.

3) For any of these codes, if the most significant bit is set, it indicates an error for that operation.

The initialization codes can be viewed in the housekeeping section of the TIDE telemetry data. Bit 4 (bit 0 - least significant bit) of the initialization data bit is always set to a zero for all codes. This is the "TELEMETRY VALID" flag and it will reflect an "INVALID" telemetry state during the initialization. Once the IMP releases the DP and the DP informs the IMP that it is ready to begin operations, the IMP synchronizes to the spacecraft major frame and starts acquiring and outputting telemetry data. Not all of the data is valid though and the "INVALID" telemetry state will still be active. The housekeeping "MAJOR FRAME COUNTER" will initialize at 0 and start incrementing every spacecraft major frame of 9.2 seconds. At approximately the third or fourth major frame, the "TELEMETRY VALID" flag data should change state to "VALID" indicating that all telemetry data is valid and TIDE has begun normal operations.

The TIDE software is now executing the default science mode of operations. Table 3.2 lists the operating parameters for the mode of operation.

Table 3.2 Default Operating Parameters

Description	Default Parameter
Collapse Option	5
Reporting	truncated
Priority Ordering	5 0 1 2 3 4
Rice Compression	disable
Moments	disable
Direct Event Sector 0	enable
Auto Sensititivy	enable/default
Dead Time Correction	disable

3.2 Science Operations

Science modes are generated by transmitting science operation commands to configure TIDE for the new science mode. TIDE uses 32 six-second spins to define a super-spin. A super-spin was defined to be used as the highest level of synchronization for the TIDE IMP and DP software. With the exception of High-Time-Resolution, all of the TIDE science modes are initiated only on super-spin boundaries. All of the science operation commands must be previously transmitted and queued in TIDE prior to the transmission of the execute on super-spin boundary, "EXE_SS_CMD", command. Only one "EXE_SS_CMD" command is required to initiate the IMP and DP to configure to a new mode. The IMP and DP require one full super-spin to set-up the mode before implementation. For example, a set of science operation commands are transmitted to TIDE, and finally, a "EXE_SS_CMD" command is executed. The command arrives at TIDE at the beginning of a super-spin. The IMP and DP will queue this command until the beginning of the next super-spin. At that time, the IMP and DP will initiate a science mode set-up in background. Depending on when TIDE receives the "EXE_SS_CMD" command it could take up to two full superspins for TIDE to implement the new mode. The housekeeping telemetry parameter mode change pending status bit, "TCHG_PEN", will indicate a "YES" status indicating that TIDE has received the "EXE_SS_CMD" command. This flag will remain in effect until the new mode has been implemented. If any of the science operation commands are transmitted to TIDE during the mode change period, the commands will be ignored and discarded.

3.2.1 Science Modes

Since TIDE is a data oriented instrument, the science modes comprise of selecting reporting options, data transformation options and operating look-up-table configuration. Any science mode that requires a new table data load in TIDE RAM for mass or energy sweep configuration should have its data load transmitted to TIDE prior to setting up science operation commands to TIDE.

To switch to a new TIDE mode, the following types of science operations commands must be transmitted:

Collapse number
Reporting Options
High Angular Resolution mode
Look-Up Table selection (Mass and Energy sweep)
Rice compression enable/disable
Deadtime correction enable/disable

Any one or combination of the science operation commands may be transmitted to TIDE to configure for a new science mode. The commands shall be implemented using the "EXE_SS_CMD" command as described above. The science operation commands may be transmitted to TIDE in any order.

3.2.1.1 Collapse Mode - Complete Reporting

There are six collapse options that TIDE can be commanded into. The description of each of the six decimation techniques are described in 3348-FSRD-01. There are two sets of command options to select from in complete reporting.

1) Fixed Reporting

COLLAPSE — Optional. Select a collapse option as described in 3348-FSRD-01. If this command is not transmitted, the current collapse option will be used for the new mode.

FIXED_ION — This command allows the selection of any combination or all of the masses to report.

2) Rotating Ions Reporting

COLLAPSE	Optional. If this command is not transmitted, the current collapse option will be used for the new mode.
ROTAT_ION	A selection of the four masses that will rotate must be made. If any number other than 4 masses are selected for rotating in a report, then TIDE will generate a DP COMMAND error condition and the command will not take effect. This error will occur prior to the transmission of the EXE_SS_CMD command.

3.2.1.2 Collapse Mode - Truncated Reporting

As described in 3348-FSRD-01, maximum time resolution is the science benefit of this reporting mode. This report can be selected by executing the following commands:

COLLAPSE	Optional. If this command is not transmitted, the current collapse option will be used for the new mode.
TRUN_RPT	This command places TIDE in a truncated mode of reporting. No parameters are required for this command.
PRI_ORDER	This command allows the selection of one of two priority ordering schemes. The two schemes are described in 3348-FSRD-01. Note: If the current priority scheme is "one" and a selection is made to a complete report mode, then the priority scheme will revert to scheme "zero".

3.2.1.3 High Time Resolution

According to document 3348-FSRD-01, this is condsidered a science sub-mode. This mode uses the reporting options as described above. The execution of the command "HTR_EN" does not require that the command "EXE_SS_CMD" be excuted. The "HTR_EN" command is executed on receipt. Setting the parameters for the command is described in detail in Appendix H of 3348-FSRD. If the command is transmitted without any of the trigger mask flags set, then TIDE will automatically trigger high time resolution for the specified dwell period. Once the high time resolution is triggered, then it enters into collapse option 5 and truncated reporting. The priority ordering of HTR mode uses is the state of the current priority order. The command "HTR_DIS" clears all of the trigger flags and returns to the original reporting state after the end of the dwell period.

E	= EFI trigger mask (0 = EFI not a trigger, 1 = EFI contributes to a valid trigger)
H	= Hydra trigger mask (0 = Hydra not a trigger, 1 = Hydra contributes to a valid trigger)
M	= moment trigger mask (0 = moment variability will not trigger high time resolution, 1 = moment variability contributes to a valid trigger)
O	= AND/OR of the selected E, H, M signals. The Boolean operator (0 = AND ; 1 = OR) is applied to all of the signals (EFI, Hydra, Moment Variability), which are selected in their corresponding mask field with a one. If the result is one, the High Time Resolution Mode is triggered.)
SSSS	= number of standard deviations. If the valid trigger M is set and the moment results vary from the history of moment results by >= SSSS standard deviations, this will result in a HTR trigger.
DDDD	= number of complete superspins that the instrument dwells in High Time Resolution Mode. (Since HTR Mode may begin on any spin boundary, the mode will typically last for DDDD.FFF superspins, where FFF is some fraction of a superspin.)

NOTE: If the E, H, and M flags are all zero, then this command shall automatically trigger high time resolution for the specified dwell period.

3.2.1.4 High Angular Resolution Mode

The command "HAR_EN" is used to command TIDE to a high angular resolution mode as described in 3348-FSRD. This command must be followed by a "EXE_SS_CMD" command to initiate this science sub-mode. The default phase shift dwell is set at one super-spin. The phase shift dwell can be changed prior to commanding HAR mode by the command "HAR_PH_DW". This mode does not perform anything differently to the data. TIDE performs a shift in time when the data is acquired relative to the spin pulse. HAR can operate in any collapse mode.

HAR mode uses a programmable hardware feature that allows the TIDE internal spin pulse to be offset from the spacecraft spin pulse. This is an 8-bit number with a resolution of .087891 degrees/bit. The high angular resolution mode uses this feature to shift the spin phase a fixed amount. Each energy sweep is 11.25 degrees of the spacecraft spin phase. High angular resolution mode shifts the spin phase by approximately every 2.81 degrees. The shift will occur on the spin boundary based on the commanded number of spins to dwell. It will make 7 shifts of approx. 2.81 degrees and then "flyback" to the 0 degree point and start over. When the software performs a flyback to 0, the data for that spin is invalid due to the disruption in spin timing. There is a instrument parameter named "Current Phase Shift". that tells what the current phase shift is. As a turn-on default, it will reflect 255 for 0 degrees. To convert this number to the phase shift in degrees, take the one's complement of the number and multiply by .087891. The spin shift numbers that come out for each dwell period are 255, 223, 191, 159, 127, 95, 63 and 31.

In addition, there is a command that will allow changing the phase shift to a fixed angle. The command is "CNS_PS_EN". The parameter must be in one's complement of the desired angle. The range of the parameter is 0 to 255 representing a phase shift of 0 to 22.5 degrees. The same conversion as used above can convert the desired angle in degrees to a one's complement integer.

3.2.2 Data Options

3.2.2.1 Dead Time Correction

Dead time correction can be enabled by transmiiting the command "DTC_EN". Dead time correction can be disabled by transmitting the command "DTC_DIS". The command, "EXE_SS_CMD", must be executed for the function to be implemented.

3.2.2.2 Rice Compression

Rice compression provides a lossless compression scheme that is applied to the TIDE science data prior to data transmission. Rice compression can be enabled by the "RICE_EN" command. Rice compression is disabled by the "RICE_DIS" command. The command, "EXE_SS_CMD", must be executed for this function to be implemented.

3.2.3 Table Look-Up Configuration Options

TIDE flight software has the capability of uploading data tables for the mass look-up, energy sweep and autosensitivity thresholds. These tables can configure TIDE for other modes than those that are resident in ROM.

3.2.3.1 Mass Look-Up-Table (MLUT)

The MLUT is a RAM memory that is a part of the TIDE data acquisition system. It uses as an input the 8-bit time-of-flight data that is the digitized data of the TOF Electronics analog output indicating the difference in time from the start and stop MCP for a particular event. The MLUT outputs a 4-bit code that is used as part of the address to the data acquisition system.

The first 3-bit output of the MLUT can be configured to produce a code from 0 to 4 with each code representing a known TOF range. The fourth bit is used as a "no-bin" bit. When one or more of the 256 memory locations representing a TOF channel is not specified to produce a TOF range output code, then it is set to an 8. This code informs the hardware data acquisition system to not accumulate this data event. A TOF range is specified as a low number and a high number between 0 and 255. The range end-points are inclusive.

The MLUT is completely reconfigurable. The TOF ranges associated to a mass number are descibed in the flight software as mass descriptors. TIDE has eight predefined descriptors resident in ROM. The TOF ranges assigned to these descriptors is shown in Appendix C of document 3348-FSRD-01. They are numbered 0 through 7. Eight more descriptors can be loaded into TIDE by one of two ways. The first is a data load that specifies eight descriptors that are assigned 8 through 15 in TIDE. The second is by a MLUT entry specification command, "LUT_E_SPEC". Each descriptor can be "built" by a single command specifying the RAM entry number (0 through 7 representing descriptor assignments 8 through 15, respectively) and the beginning and end TOF channel for the TOF range. Eight entry specification commands would be required to manually "build" all eight RAM MLUT descriptors.

Table 3.3 lists the eight descriptors that are programmed in TIDE ROM. At TIDE turn-on the MLUT is built using the ROM descriptors as shown in Table 3.3.

Table 3.3 MLUT Descriptors in ROM

Descriptor Number	Beginning TOF Channel	Ending TOF Channel	Species	Mass Assignment at Turn-On
0	1	7	BKG	0
1	8	25	H+	1
2	26	41	He++	2
3	42	70	He+	3
4	71	105	O++	4
5	106	130	N+	
6	106	156	O+	
7	157	254	N_2O_2+	

An example of a MLUT data load for loading all eight descriptors is shown in Appendix A. The data load follows the data load format as described in document 3348-FSRD-01. A specific description of the data load follows:

`B200000006`	This is the start record of the data load. The first 11 bits specifies 6 as the number of commands in this load.
`B304000010`	This is the data block header record. It specifies to the TIDE flight software the type of load (code of 4 in bit positions 24 through 31) and that 16 actual bytes will be loaded.
`B364821E3C`	This is the first data record. According to the MLUT data load format. Bits 0 through 7 specifies the end channel number for descriptor 8. Bits 8 through 15 specifies the starting channel number for descriptor 8. Bits 16 through 23 specifies the end channel number for descriptor 9. Bits 8 through 15 specifies the starting channel number for descriptor 9. Three more data records are required to specify the beginning and end channel numbers for the remainder of the 7 descriptors. Each data record contains the start and end channel numbers for two descriptors as shown in Appendix A.
B3133E6DDB	A checksum is required to complete the data load. The checksum is calculated by summing all doubleword (32-bit) commands in the data load, including the start record and the data block header record.

Once the RAM descriptors have been loaded either by a data load or manually by the entry specification command, the eight RAM descriptors can be used to specify which five descriptors are assigned to masses 0 through 4 to be used for the new science mode. The science operation command "LUT_BLD" is used to command TIDE to "build" the MLUT during the set-up superspin in preparation for the new mode. The command requires that five unique descriptor numbers ranging from 0 through 15 be selected to represent masses 0 through 4. A "EXE_SS_CMD" is required for TIDE to implement the MLUT build. Once the MLUT is built, the contents of the MLUT can be dumped for verification (see section 3.3.1.2).

The TIDE MLUT is a RAM device that is double buffered to allow building the new MLUT during the set-up superspin without interrupting normal science data acquisition. TIDE software builds the new MLUT in the inactive portion of the RAM during successive accumulation period dead-times. At the super-spin boundary of a complete set-up superspin, the TIDE software will switch the inactive MLUT to be the active table.

Two additional commands are provided for management of the MLUT. The command "LUT_SWAP" can be used to swap the inactive table for the active table for a new science mode. After TIDE turn-on, the "LUT_SWAP" command should not be used until a "LUT_BLD" command has been used to switch MLUTs. This will ensure that a valid MLUT is in the inactive table when a new mode is invoked. The command "LD_P_DFLT" can be used to load the original default descriptors used at turn-on.

3.2.3.2 Energy Sweep Tables

TIDE uses a Retarding Potential Analyzer (RPA) and a Mirror (MIR) front-end to perform energy analysis of incoming particles. TIDE performs a 32-step energy sweep with each step being 5.86 milliseconds. The TIDE software uses a look-up table to drive the digital to analog converters for controlling the RPA and MIR power supplies for each step. Both power supplies have a range of 0 to 300 Volts. The RPA control is specified by a 12-bit command. The MIR control is specified by a 8-bit command that represents the ratio of the MIR voltage to the RPA voltage. Each energy sweep contains the top most step as the first step and steps down. The 32nd and last step of the sweep is used to flyback the power supplies to its initial top step. The science data collected from this step is not valid.

TIDE contains five energy sweep tables numbered 0 through 4 in ROM. Each energy sweep table contains three parts. The first part contains 32 entries of 12-bit RPA commands. The second part contains 32 entries of MIR/RPA indexes. Finally, there is a 16-entry table that contains the 8-bit MIR/RPA ratio commands in percentage. Each entry in the MIR/RPA index table is used to point to one of sixteen entries of the MIR/RPA ratio table to determine the ratio to use for each energy step. Each energy step can uniquely specify what RPA voltage, and what MIR/RPA ratio to use by way of the MIR/RPA index table. The five default tables are specified in Appendix A of document 3348-FSRD-01. Table 0 is the default table at TIDE turn-on.

Two additional energy sweep tables can be loaded into TIDE RAM by way of a data load. An example energy sweep data load is shown in Appendix B. The data load follows the data load format as described in document 3348-FSRD-01. A specific description of the data load follows:

`B20000003A` This is the start record of the data load. The first 11 bits specifies 58 as the number of commands in this load.

`B304000010` This is the data block header record. It specifies to the TIDE flight software the type of load (code of 6 indicating energy sweep table 0 in bit

	positions 24 through 31) Finally, 224 actual data bytes to be loaded is specified in bit positions 0-10.
B300000FFF	This is the first data record. According to the ESWEEP data load format. Bits 0 through 11 specifies the RPA command for step 0 of the sweep. Thirty-one additional data records are required to specify the RPA command for each energy step. The last step should contain the contain the same RPA value as the first step to initiate a fly-back.
B300010000	The next 16 data records specify the MIR/RPA ratio indexes for each step. Bit positions 0 through 3 are used to specify the index for energy step 0. Bit positions 16 through 19 are used to specify the index for energy step 1. Each data record specifies two indexes for two steps. The remaining 15 records specified the indexes for the remaing 30 energy steps.
B3001A000D	The final 8 data records specify the 16 actual ratios for the MIR supply to be indexed by the MIR/RPA ratio table. Bit positions 0-7 specify the MIR/RPA ratio of index 1. Bit positions 16-23 specify the MIR/RPA ratio of index 2. The remaining seven data records specify the remaining 14 MIR/RPA ratios.
B30A4F07BF	A checksum is required to complete the data load. The checksum is calculated by summing all doubleword (32-bit) commands in the data load, including the start record and the data block header record.

Once the RAM energy sweep table(s) have been loaded by a data load, the RAM energy sweep table can be used for the new science mode. The science operation command "SEL_E_SWP" is used to command TIDE to use either the five ROM tables or the uploaded RAM table during the set-up superspin in preparation for the new mode. The command requires two parameters for execution. The energy sweep table number (0-6) must be specifed along with a execution parameter of "0". The execution parameter indicates when the energy sweep table shall be implemented. A "0" indicates the implementation of the energy sweep table on a super-spin boundary following a set-up super-spin, and a "1" specifies that the energy sweep table is to be implemented on the next spin boundary. When the execution parameter of "0" is specified, the command "EXE_SS_CMD" must be transmitted for TIDE to implement the new energy sweep table. The execution on spin boundary is primarily used for ground testing and calibration of TIDE. It is recommended to use the super-spin execution parameter to synchronize all TIDE science operations to a super-spin boundary.

An additional command is provided to swap energy sweep tables. The command "E_OP_SWAP" swaps the active table with the inactive table. This command operates on a spin boundary. It should be noted that the inactive table contains zeros as a TIDE turn-on default.

3.2.3.3 Automatic Sensitivity Control

Automatic sensitivity control is used to avoid excessively high counting rates from the microchannel plates. The TIDE flight software implements an algorithm that is described in 3348-FSRD-01. The effect of the algorithm is to decrease the MIR/RPA ratios to reduce the high count rates based on a hierarchy of scalar threshold values.

A data load is required to change the varioius scalar threshold values and the default count threshold. An example of the data load is presented in Appendix C. The data load follows the data load format as described in document 3348-FSRD-01. A specific description of the data load follows:

B280000005	This is the start record of the data load. The first 11 bits specify 58 as the number of commands in this load.
B38100000C	This is the data block header record. It specifies to the TIDE flight software the type of load (code of 81(HEX) indicating autosensitivity threshold values in bit positions 24 through 31). Finally, 12 actual data bytes to be loaded are specified in bit positions 0-10.
B302580154	This is the first data record. Bits 0 through 15 specify the threshold 0 value and bit positions 16-30 specify the threshold 1 value.
B3032002BC	This is the second data record. Bits 0 through 15 specify the threshold 2 value and bit positions 16-30 specify the threshold 3 value.
B300040384	This is the third data record. Bits 0 through 15 specify the threshold 4 data value and bit positions 16-30 specify the count threshold value.
B3067C07A5	A checksum is required to complete the data load. The checksum is calculated by summing all doubleword (32-bit) commands in the data load, including the start record and the data block header record.

At TIDE turn-on, automatic sensitivity control is enabled in the default mode. The command "AUTOS_DIS" can be issued to disable sensitivity control. Command "DEF_A_S_EN" is required to enable the default mode of operation. The command

"OPT_A_S_EN" will enable the automatic sensitivity mode to the optional condition.

3.3 Engineering Operations

3.3.1 TIDE Dump Data Mode

The TIDE software produces three types of dump data products. They are DP, IMP, and IMP mass look-up table data products. The dump data products are generated for one complete super-spin. The command "ADD_MEMDMP" along with a start dump address specified in 20-bit hexadecimal is required to be transmitted prior to the execution of any dump command. The address commanded is contained in the first dump data product of the super-spin. Each data product contains the four-byte beginning TIDE internal memory address of the data for that data product. The data is dumped sequentially from the specified address until the end of the super-spin is reached.

Note: If dump mode is commanded while in normal science complete reporting mode that requires multiple spins to report on the data, the data product continuation number may not be correct when dump mode completes after one full superspin. The incrementing continuation number will be invalid while TIDE will finishes the previous complete report mode that was interrupted by the dump mode. The continuation number will be re-initialized at the next complete report.

3.3.1.1 Instrument Mode Processor (IMP) Dump

The command "IMP_DUMP" followed by a "EXE_SS_CMD" is required to initiate the IMP dump. At the beginning of the super-spin after one complete set-up superspin, the dump data products with ID 219 will be generated. The first four data bytes in each data product generated for the IMP general purpose dump contains the starting address of the data in the data product. For example, a "00 F8 04 00" would be the address 04F800 in hexadecimal. There are 1024 bytes of dump data in each data product.

3.3.1.2 IMP Mass Look-Up Table Dump

To initiate a MLUT dump, an address of 80000 hexadecimal must be commanded using the command "ADD_MEMDMP". The command "IMP_DUMP" followed by a "EXE_SS_CMD" is required to initiate the IMP MLUT dump. At the beginning of the super-spin after one complete set-up superspin, the dump data products with ID 218 will be generated. The first four bytes of each data product contains the address formatted as shown above. The even spins will contain the MLUT dump of the active MLUT. The odd spins will contain the

MLUT dump of the inactive MLUT. The inactive table is identified by an address of 80001 hexadecimal. There are 512 data bytes per MLUT dump data product.

3.3.1.3 Data Processor (DP) Dump

The command "DP_DUMP" followed by a "EXE_SS_CMD" is required to initiate the DP dump. At the beginning of the super-spin after one complete set-up superspin, the dump data products with ID 220 will be generated. The first four data bytes in each data product generated contains the starting address of the data in the data product. For example a "00 71 08 00" would be the address 087100 in hexadecimal. There are 1024 bytes of dump data in each data product.

NOTE: If an odd address is specified as the starting address, the DP will subtract one from the specified address and start the dump to align the data on an even address boundary.

3.3.2 Pulser Operations

TIDE has an internal pulser capability that can be used to verify the functionality of the TIDE TOF electronics and the data acquisition system. There are two methods of turning on the pulser.

3.3.2.1 Single Command Option

There is a single commanding option that allows one of seven sectors, one of eight delay rates and one of sixteen repetition rates to be selected. The delay rate selection allows a fixed delay between the start pulse and stop pulse to determine the TOF channel to which the data is to be "binned". The following commands are required to operate the pulser in single command mode.

SEL_C_RATE — Two parameters are required. A delay rate (0-7) and a rep rate (0-15) must be selected.

SEL_C_TOF — Only one sector may be selected. There are seven parameter fields for this command. Each field represents a sector to select. The first parameter after the command is the sector 7 parameter. The fields descend from there. Select which sector is to be turned-on by using a parameter of "1". Place a parameter of "0" for the remaining six parameter fields.

P_1_CMD_EN — This enables the pulser to turn-on using the parameters used above.

C_PUL_DIS This disables and turns-off the pulser.

3.3.2.2 Multiple Command Option

A data load capability is provided to allow the pulser on/off, sector, delay and rep rate to vary from energy step to energy step for the duration of a six second spin. There are 1024 energy steps in a spacecraft spin and, therefore, 1024 pulser commands that are loaded in a RAM table. Each entry in the table is executed in sequence from beginning to end for one spin. The command is executed by the software during each energy step's dead time period. Two data loads are required to completely load the table. An example of the first of two data loads is presented in Appendix D. The data load follows the data load format as described in document 3348-FSRD-01. A specific description of the data load follows:

B200000102 This is the start record of the data load. The first 11 bits specify 258 as the number of commands in this load.

B308000400 This is the data block header record. It specifies to the TIDE flight software the type of load. A code of 8 indicates pulser sequence table A in bit positions 24 through 31. A code of 9 indicates the pulser sequence table B. Finally, 1024 actual data bytes to be loaded are specified in bit positions 0-10.

B388028802 This is the first of 256 data records. Each data record contains the sector, delay, rep rate and on/off specification for two energy steps. Sixteen data records are required to specify the parameters for one of 16 angular sectors (32 energy steps) for this load.

B37B2E77A2 A checksum is required to complete the data load. The checksum is calculated by summing all doubleword (32-bit) commands in the data load, including the start record and the data block header record.

Once the two loads have been transmitted to TIDE, the command "P_M_CMD_EN" can be executed to start the multiple pulser capability. The command will start executing on the next spin boundary. The command "C_PUL_DIS" will disable and turn-off the pulser.

3.3.3 Debug and Alternate ROM Modes

At a power-on-reset, either by the turn-on of TIDE or the issuance of the IMP Reset command, the flight software enters into a 30-second wait to allow the user to issue the BOOTSTRAP 2 command. The command will place TIDE into a debug mode. This mode was envisioned to be a method to perform diagnostics in case the flight software cannot perform a normal turn-on and initialization due to a hardware anomaly. The debug mode outputs the standard TIDE housekeeping telemetry data so that housekeeping parameters can be evaluated. The initialization codes for debug mode are shown in Table XX. Debug mode is initiated in both the IMP and DP. Once debug has been initiated, the IMP and DP software generates a standard ASCII message every spin to indicate that it is ready for a dataload. The messages of the IMP and DP output are as follows:

[<TIDE IMP DEBUG> Ready for upload.]

{<TIDE DP DEBUG> Ready for upload.}

The debug mode awaits further commands in the form of a diagnostic program upload to execute and report the results. The debug mode gives the operations team flexibility in uploading various diagnostics programs to investigate hardware anomalies. The intention is for the diagnostics programs to perform tests and report the results in the form of ASCII messages.

At turn-on or reset, the flight software executes code from memory address 0, which is the first PROM. An alternative method is provided in the TIDE hardware to allow starting the flight software from another memory address. The command BOOTSTRAP 1 performs a reset to TIDE and sets bit 14 of the address bit to intiate flight software from another PROM. As can be seen from Table 3.4, the initialization code is different for ALT ROM. Once again, the software will wait 30 seconds for a debug command. If a command is not issued, then the software attempts to boot the main software and perform normal operations.

Table 3.4 TIDE Initialization Codes

Initialization Code	Initialization Function
Normal Startup	
1	30 second wait for possible command debug flag
ALT-ROM	
A0	Alt-ROM boot initiated

Initialization Code	Initialization Function
A1	30 second wait for possible command debug flag. Jumps to normal startup or debug startup
	Debug Startup
D1	processor configuration
D2	stack RAM test, interrupt table initialization
D3	Load part 1 of program code from ROM to RAM and verify
D4	Load part 2 of program code from ROM to RAM and verify
D5	Test/clear RAM data space
D6	Perform ROM checksum
FD	Jump to debug main program in RAM
	Debug Initialization
D2	Shared memory test
D3	Install interrupts
D5	Waiting for telemetry major frame sync, once synced telemetry data output initiated
	Fill Pattern
D6	Turn on minor frame and telemetry interrupt
D7	Release DP reset, initialize debug text string
D8	Hardware latch initializations: Sample clock, phase shift, remap PROMs, power supply DACs
D9	Wait up to 90 seconds for DP to indicate presence
0	Enable all interrupts and start acquisition system; jump to debug main

3.4 Spacecraft Modes

TIDE can change telemetry output data formats in response to a spacecraft mode change command. TIDE supports four spacecraft modes; science, manuever, contingency, and engineering. The TIDE telemetry allocation for all the spacecraft modes are reflected in the Lockheed Martin document, Polar Command and Telemetry Handbook Rev. 3.1 Issue Date: Jan. 15, 1995.

There is no change in the TIDE telemetry allocation between the science mode and the manuever mode. Contingency mode increases the TIDE telemetry allocation from 4,007 bps to 8,696 bps. In response to an engineering mode command, TIDE turns-off the science data telemetry queue and outputs the housekeeping data at the lower telemetry rate. Due to the timing relationship between the sun pulse and the major frame sync, the software telemetry queue could keep getting filled with science data while the telemetry queue output is turned-off until the software recognizes the mode change at the beginning of the next spin. In this situation, a TLM QUEUE ERROR flag may be generated when commanded to engineering mode. The TIDE command "CLR_ER_FLG" must be used to clear the TELEMETRY QUEUE ERROR flag. The state of TIDE in the spacecraft modes is reflected in the telemetry housekeeping parameter "TINSMODE".

3.5 Telemetry Data

3.5.1 Science Data

The science data are packetized in data products as defined in document 3348-FSRD-01. There are 184 data product types that TIDE can generate depending on the science mode selected.

Science data are telemetered in structures called spin packets. The spin packets are not synchronous with the telemetry frame, rather they may begin and end anywhere in a major frame of data. The spin packets are approximately spin synchronous. The spin packet format is shown in Appendix J of the Software Requirements Document, 3348-FSRD-01. Each spin packet consists of a header, followed by a varying number of data products.

3.5.1.1 Spin Header

Each spin packet contains a spin header consisting of the following items:

a. Sync Word

The sync word appears in the telemetry stream as $EB90_{16}$. It marks the beginning of a spin packet.

b. Spin Packet Length

The total length, in bytes, of the spin packet is a word in the spin packet header. The low byte of the length is telemetered first.

c. Mode ID

The mode ID indicates the mode in which each processor is operating relative to the data in the current spin packet. The mode ID is the sum of the IMP and DP processor modes. Listed below are the mode ID numbers for each processor mode:

0 = IMP dump and DP dump*
1 = not valid
2 = IMP science and DP dump
3 = IMP dump and DP science
4 = not valid
5 = IMP science and DP science

* If both the IMP and DP are commanded to dump, only the IMP dump data products are telemetered.

d. Spin Counter

This counter counts from 0 to 255 and rolls over. It is incremented by one each spin.

e. Time Tag

This time tag is associated with the items in the spin packet header. It marks the end of the acquisition spin of corresponding data. The time tag consist of a major frame counter, a minor frame counter, and a telemetry word counter. The same major frame counter is inserted in the housekeeping data. The timetag major frame counter indicates the major frame when the sun pulse occurred which began the acquisition of the data. Because a Universal Time is also stored by the spacecraft in each major frame, the time of data collection can be related to the Universal time.

f. Continue Number

This number is relevant when the instrument is in Complete Reporting Mode. It numbers, from 0 to n, the spin packets that contain data collected from the same spin.

g. MAGAZ

This word contains a count of the spin phase reference clock (4096 pulses per spacecraft revolution) from the TIDE hardware indicating when a MAGAZ magnetic field vector pulse from the spacecraft was generated. The pulse is an indication when the magnetometer detects a descending zero crossing in By. To convert the count to degrees, multiply by 360/4095.

h. MAGEL

This byte contains the count of the spin phase reference clock that was delivered after the MAGAZ pulse occurs. The count is the magnetic field elevation in degrees from +z.

i. Accumulation Period

This is the length of the sample accumulation period for the current spin. The equation of determine seconds per sample is 6.0/1024.0 - (acc_per - 127) * 0.0000005

j. TOF Efficiency Numbers

The TOF efficiency numbers are the total counts for stops, resets, timeouts, or start converts every fourth spin. Each spin contains one integer*4 (low order byte first) data element.

k. Moments

Thirty-six bytes are used to contain lossy compressed moments results. For each of the five masses, the bytes are energy centroid and width, spin centroid and width, polar centroid and width, followed by doubly compressed total counts for each mass. The 36th byte is a spare.

l. Invalid Events

This value is the lossy compressed sum of all invalid events (channel zero events) that occurred during the spin.

m. Trickled Direct Events

Direct Events (256 TOF bins for each sector) are accumulated over a superspin (32 spins), and every other bin is trickled down in the spin headers of the subsequent superspin. Twenty-eight integer*4 (lower order byte first) values are reported each spin. Even-numbered bins (0-254) are reported in even-numbered superspins, odd-numbered bins (1-255) are reported in odd-numbered superspins.

n. Commands Received Counter

The total number of commands received during the current spin is reported.

o. Data Product Counter

The total number of data product packets in the spin packet is contained in this byte.

p. Spin Header Checksum

A one byte checksum over the spin packet header is calculated by summing every byte in the spin header except the sync byte.

3.5.1.2 Data Product Packets

Each data product contains seven-bytes that constitutes a data product header.

Each data product header contains the following:

a. Sync Byte

The sync byte signifies the beginning of the data product. It is represented by $B8_{16}$.

b. Data Product I.D.

A one-byte unique data product identifier is assigned to every data product that TIDE generates. The data product identification number assignments are shown in Appendix A.

c. Length

A two-byte field is used to indicate the length of the data product. The length includes the data product header and the checksum. The most significant bit of the packet length is a Rice Compression status bit indicating whether that data product has been compressed (0 = no compression, 1 - compression).

d. Time tag

The three-byte time tag is used to uniquely stamp the data product. This is used primarily for generating complete reports. A description of the time tag is presented in paragraph 3.5.1.1 above.

f. Checksum

A one-byte checksum over the data product is calculated by summing every byte in the data product with the exception of the sync byte.

3.5.1.3 Science Data Products

As shown in Appendix A there are numerous data products that can be generated depending on the collapse and reporting options described in the Software Requirements

Document, 3348-FSRD-01. The format of each of the different collapse option data products are desribed in more detail in paragraph 3.2 of 3348-FSRD-01.

3.5.1.4 Instrument Parameters

Instrument parameters are reflected in two data products. The two data products are called Instrument Parameters and Instrument Parameter Changes. The Instrument Parameters data product is generated at the beginning of each super-spin and is the first data product following the spin header that corresponds to a superspin boundary. The instrument parameters data product reflects the state of TIDE for that super-spin. This data product has an identification number of 221. There are a subset of the instrument parameters that could change during the course of a super-spin. Examples of parameters that can change are high voltage power supply settings, autosensitivity control, EFI/HYDRA interface change for high time resolution mode, and high angular resolution mode parameter changes. When a change occurs, then a instrument parameter changes data product is generated at the spin boundary. This data product has an ID of 222 and is generated only when a change has occurred to any parameter within the data product. The details and format of both of these data products are shown in Appendix K of document 3348-FSRD-01.

3.5.1.5 Direct Events Sector 0 Data Product

By default, the Direct Events Sector 0 data product (I.D. 233) is generated once per superspin and telemetered as the second data product of the superspin. The telemetry of this data product may be disabled by command DP_DE0_DIS or re-enabled by command DP_DE0_EN.

3.5.1.6 Dump Data Product

When commanded to dump mode, the entire superspin science data allocation is used to dump memory. Memory is dumped for one superspin and then reverts to the previoius science mode. Details of the dump mode are described in section 3.3 above.

3.5.2 Housekeeping Data

There are 46 bytes of Polar telemetry words allocated for TIDE housekeeping. The TIDE housekeeping data is updated once per major frame (9.2 seconds). Low voltage monitors, high voltage monitors, temperature monitors, and status monitors are telemetered to determine the health and safety of TIDE. Appendix I of the Software Requirements Document, 3348-FSRD-01 presents the detail allocation of the TIDE housekeeping data. The Lockheed Martin Polar Command and Telemetry Handbook reflects the spacecraft listing of the TIDE housekeeping.

3.6 PSI Operations

The Plasma Source Instrument (PSI) consists of three power supplies generating a commandable voltage and current source to operate the PSI source that ignites and emits Xenon gas. A valve on command is required to initiate gas flow to the source. Table 3.5 shows the PSI power supply commands and the resulting voltage and current outputs depending on the level selected.

Table 3.5 PSI Power Supply Command Voltage/Current Outputs

Command Mnemonic	**Nom. Output Voltage**	**Nom. Output Current**
H_PS_ON_L1	4.36 V	1.68 A
H_PS_ON_L2	7.04 V	2.70 A
H_PS_ON_L3	7.52 V	2.91 A
H_PS_OFF	0.00V	0.00A
D_PS_ON_L1	23.9 V	198.5 mA
D_PS_ON_L2	36.0 V	300.0 mA
D_PS_ON_L3	53.6 V	447 mA
D_PS_OFF	0.00 V	0.0 mA
K_PS_ON_L1	18.4 V	254.5 mA
K_PS_ON_L2	30.0 V	399.7 mA
K_PS_ON_L3	32.2 V	430 mA
K_PS_OFF	0.0V	0.0 mA

The next two paragraphs describe the procedure for performing cathode conditioning and performing ignition, respectively. Each step of the procedure is followed by commands that are required to place PSI in the proper operating configuration. These two procedures assume that TIDE and PSI are powered-on and operating nominally.

3.6.1 Cathode Conditioning Procedure

1) Turn valve on.

   VALVE_ON

2) Turn on heater supply to 1.72 A; leave on for 3 hours.

   H_PS_ON_L1

3) After 3 hours, turn off heater supply for 30 minutes.

   H_PS_OFF

4) After 30 minutes, set heater supply to 2.8 A; leave on for one hour.

   H_PS_ON_L2

5) After one hour, cathode conditioning is complete. At this point, operator may either turn off the heater (H_PS_OFF) and close the xenon gas valve (VALVE_OFF) or execute the source ignition procedure (described in Section 3.6.2, below).

3.6.2 Source Ignition Procedure

1) Turn valve on.

   VALVE_ON

2) Set heater on to 2.8 A for 5 minutes.

   H_PS_ON_L2

3) After 5 minutes, set keeper supply to 400 mA.

K_PS_ON_L2

4) If keeper current is within 50 mA of the commanded 400 mA, then the PSI source has ignited; proceed to step 13. Otherwise the source has not ignited; proceed to step 5.

5) If the source did not ignite. Turn keeper supply off; and let the heater operate at the 2.8 A setting for an additional 5 minutes.

K_PS_OFF

6) After 5 minutes, set keeper suppply to 400 mA.

K_PS_ON_L2

7) If keeper current is within 50 mA of the commanded 400 mA, then the PSI source has ignited; proceed to step 13. Otherwise the source has not ignited; proceed to step 8.

8) If the source did not ignite, turn off the keeper supply and set the heater on at the 2.91 A setting for 5 minutes.

K_PS_OFF
H_PS_ON_L3

9) After 5 minutes turn the heater supply down to 2.7 A.

H_PS_ON_L2

10) Set keeper supply to 400 mA.

K_PS_ON_L2

11) If keeper current is within 50 mA of the commanded 400 mA, then the PSI source has ignited; proceed to step 13. Otherwise the source has not ignited; proceed to step 12.

12) If the source did not ignite, turn off the supplies, turn off PSI, close the xenon gas valve and convene engineering team to determine future course of action.

K_PS_OFF

H_PS_OFF
VALVE_OFF

13) Keeper ignition - Turn heater off, turn discharge supply to 200 mA, and set keeper current to 250 mA. Operate for one hour.

H_PS_OFF
D_PS_ON_L1
K_PS_ON_L1

14) To turn off PSI, turn off discharge and keeper power supply. Turn valve off.

D_PS_OFF
K_PS_OFF
VALVE_OFF

APPENDIX A

No Collapse (Collapse Option 0)

Mass	Sectors in Data Product	Length of Data Product	Data Product ID
0	1	1000 ($3E8_{hex}$)	0 (0_{hex})
	2	1000	1
	3	1000	2
	4	1000	3
	5	1000	4
	6	1000	5
	7	1000	6
1	1	1000 ($3E8_{hex}$)	7 (7_{hex})
	2	1000	8
	3	1000	9
	4	1000	10
	5	1000	11
	6	1000	12
	7	1000	13
2	1	1000 ($3E8_{hex}$)	14 (E_{hex})
	2	1000	15
	3	1000	16
	4	1000	17
	5	1000	18
	6	1000	19
	7	1000	20
3	1	1000 ($3E8_{hex}$)	21 (15_{hex})
	2	1000	22
	3	1000	23
	4	1000	24
	5	1000	25
	6	1000	26
	7	1000	27
4	1	1000 ($3E8_{hex}$)	28 ($1C_{hex}$)
	2	1000	29
	3	1000	30
	4	1000	31
	5	1000	32
	6	1000	33
	7	1000	34

Mass	Sectors in Data Product	Length of Data Product	Data Product ID
5 (singles)	1	1000 ($3E8_{hex}$)	35 (23_{hex})
	2	1000	36
	3	1000	37
	4	1000	38
	5	1000	39
	6	1000	40
	7	1000	41

Energy Collapse (Collapse 1)

Mass	Sector in Data Product	Length of Data Product	Data Product ID
0	1	520 (208_{hex})	42 ($2A_{hex}$)
	2	520	43
	3	520	44
	4	520	45
	5	520	46
	6	520	47
	7	520	48
1	1	520 (208_{hex})	49 (31_{hex})
	2	520	50
	3	520	51
	4	520	52
	5	520	53
	6	520	54
	7	520	55
2	1	520 (208_{hex})	56 (38_{hex})
	2	520	57
	3	520	58
	4	520	59
	5	520	60
	6	520	61
	7	520	62
3	1	520 (208_{hex})	63 ($3F_{hex}$)
	2	520	64
	3	520	65
	4	520	66
	5	520	67
	6	520	68
	7	520	69
4	1	520 (208_{hex})	70 (46_{hex})
	2	520	71
	3	520	72
	4	520	73
	5	520	74
	6	520	75
	7	520	76

Mass	Sector in Data Product	Length of Data Product	Data Product ID
5 (singles)	1	520 (208_{hex})	77 ($4D_{hex}$)
	2	520	78
	3	520	79
	4	520	80
	5	520	81
	6	520	82
	7	520	83

Medium Angular Resolution Collapse (Collapse 2)

Mass	Sector in Data Product	Length of Data Product	Data Product ID
0	1, 2, 3	876 ($36C_{hex}$)	84 (54_{hex})
	4	1000 ($3E8_{hex}$)	85
	5	1000	86
	6, 7	752 ($2F0_{hex}$)	87
1	1, 2, 3	876 ($36C_{hex}$)	88 (58_{hex})
	4	1000 ($3E8_{hex}$)	89
	5	1000	90
	6, 7	752 ($2F0_{hex}$)	91
2	1, 2, 3	876 ($36C_{hex}$)	92 ($5C_{hex}$)
	4	1000 ($3E8_{hex}$)	93
	5	1000	94
	6, 7	752 ($2F0_{hex}$)	95
3	1, 2, 3	876 ($36C_{hex}$)	96 (60_{hex})
	4	1000 ($3E8_{hex}$)	97
	5	1000	98
	6, 7	752 ($2F0_{hex}$)	99
4	1, 2, 3	876 ($36C_{hex}$)	100 (64_{hex})
	4	1000 ($3E8_{hex}$)	101
	5	1000	102
	6, 7	752 ($2F0_{hex}$)	103
5 (singles)	1, 2, 3	876 ($36C_{hex}$)	104 (68_{hex})
	4	1000 ($3E8_{hex}$)	105
	5	1000	106
	6, 7	752 ($2F0_{hex}$)	107

Low Angular Resolution Collapse (Collapse 3)

Mass	Sector in Data Product	Length of Data Product	Data Product ID
0	1, 2, 3	456 ($1C8_{hex}$)	132
	4	520 (208_{hex})	133
	5	520	134
	6, 7	392 (188_{hex})	135
1	1, 2, 3	456 ($1C8_{hex}$)	136
	4	520 (208_{hex})	137
	5	520	138
	6, 7	392 (188_{hex})	139
2	1, 2, 3	456 ($1C8_{hex}$)	140
	4	520 (208_{hex})	141
	5	520	142
	6, 7	392 (188_{hex})	143
3	1, 2, 3	456 ($1C8_{hex}$)	144
	4	520 (208_{hex})	145
	5	520	146
	6, 7	392 (188_{hex})	147
4	1, 2, 3	456 ($1C8_{hex}$)	148
	4	520 (208_{hex})	149
	5	520	150
	6, 7	392 (188_{hex})	151
5 (singles)	1, 2, 3	456 ($1C8_{hex}$)	152
	4	520 (208_{hex})	153
	5	520	154
	6, 7	392 (188_{hex})	155

Energy/Medium Angular Resolution Collapse (Collapse 4)

Mass	Sector in Data Product	Length of Data Product	Data Product ID
0	1, 2, 3	442 ($1BA_{hex}$)	108 ($6C_{hex}$)
	4	504 ($1F8_{hex}$)	109
	5	504	110
	6, 7	380 ($17C_{hex}$)	111
1	1, 2, 3	442 ($1BA_{hex}$)	112 (70_{hex})
	4	504 ($1F8_{hex}$)	113
	5	504	114
	6, 7	380 ($17C_{hex}$)	115
2	1, 2, 3	442 ($1BA_{hex}$)	116 (74_{hex})
	4	504 ($1F8_{hex}$)	117
	5	504	118
	6, 7	380 ($17C_{hex}$)	119
3	1, 2, 3	442 ($1BA_{hex}$)	120 (78_{hex})
	4	504 ($1F8_{hex}$)	121
	5	504	122
	6, 7	380 ($17C_{hex}$)	123
4	1, 2, 3	442 ($1BA_{hex}$)	124 ($7C_{hex}$)
	4	504 ($1F8_{hex}$)	125
	5	504	126
	6, 7	380 ($17C_{hex}$)	127
5 (singles)	1, 2, 3	442 ($1BA_{hex}$)	128 (80_{hex})
	4	504 ($1F8_{hex}$)	129
	5	504	130
	6, 7	380 ($17C_{hex}$)	131

Energy/Low Angular Resolution Collapse (Collapse 5)

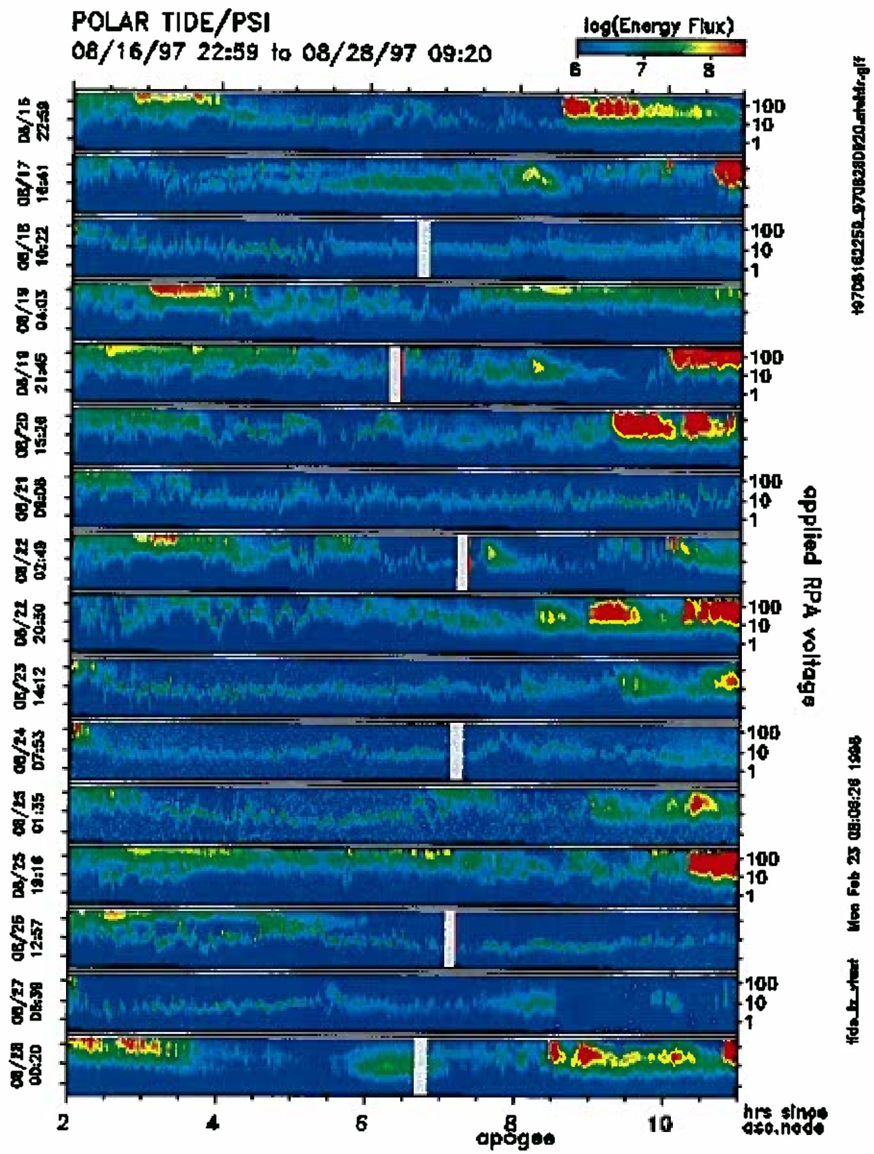
Mass	Sector in Data Product	Length of Data Product	Data Product ID
0	1, 2, 3	232 ($E8_{hex}$)	156 ($9C_{hex}$)
	4	264 (108_{hex})	157
	5	264	158
	6, 7	200 ($C8_{hex}$)	159
1	1, 2, 3	232 ($E8_{hex}$)	160 ($A0_{hex}$)
	4	264 (108_{hex})	161
	5	264	162
	6, 7	200 ($C8_{hex}$)	163
2	1, 2, 3	232 ($E8_{hex}$)	164 ($A4_{hex}$)
	4	264 (108_{hex})	165
	5	264	166
	6, 7	200 ($C8_{hex}$)	167
3	1, 2, 3	232 ($E8_{hex}$)	168 ($A8_{hex}$)
	4	264 (108_{hex})	169
	5	264	170
	6, 7	200 ($C8_{hex}$)	171
4	1, 2, 3	232 ($E8_{hex}$)	172 (AC_{hex})
	4	264 (108_{hex})	173
	5	264	174
	6, 7	200 ($C8_{hex}$)	175
5 (singles)	1, 2, 3	232 ($E8_{hex}$)	176 ($B0_{hex}$)
	4	264 (108_{hex})	177
	5	264	178
	6, 7	200 ($C8_{hex}$)	179

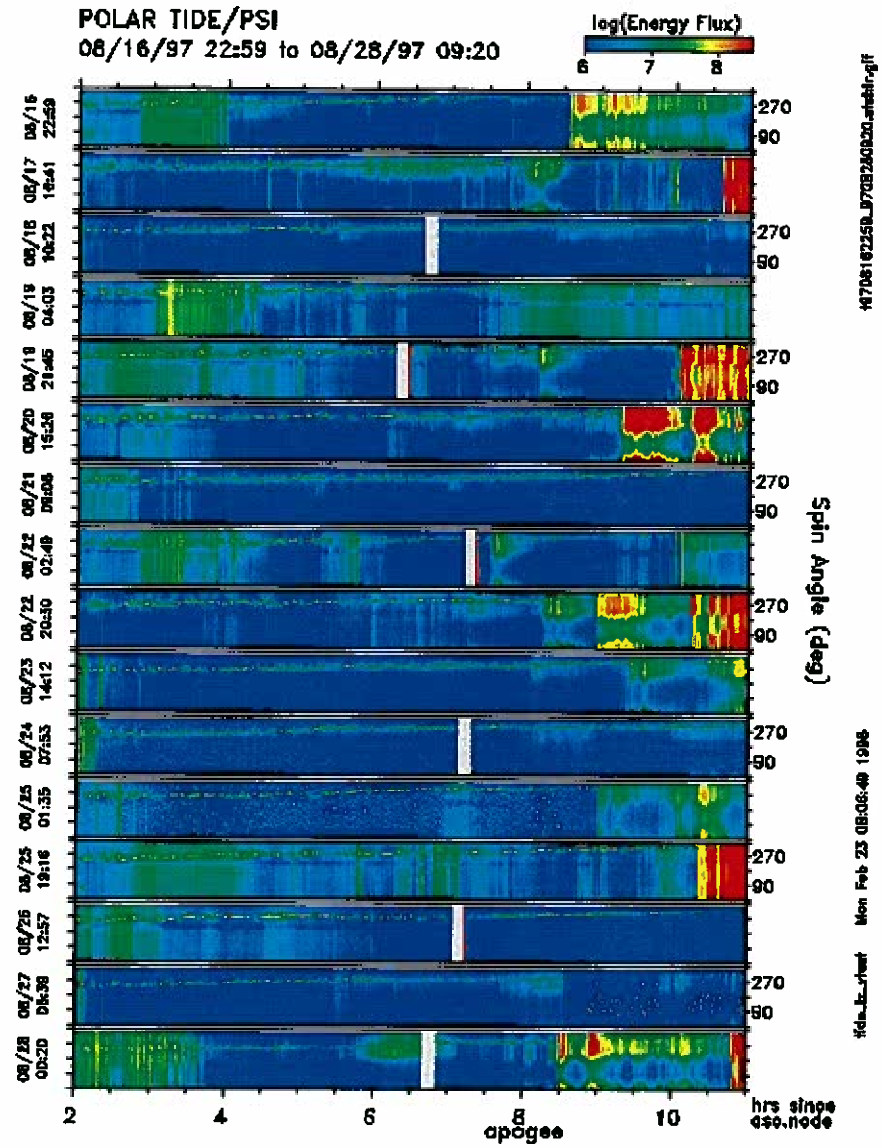
Calibration Supercollapse (Collapse 6)

Mass	Sector in Data Product	Length of Data Product	Data Product ID
0, 1, 2, 3, 4	1, 2, 3, 4, 5, 6	1128 (486_{hex})	200 ($C8_{hex}$)
all singles (starts, stops, start converts, time-outs, resets)		360 (168_{hex})	201 ($C9_{hex}$)

Miscellaneous Data Products

Type	**Length of Data Product**	**Data Product ID**
MLUT memory dump	524 ($20C_{hex}$)	218 (DA_{hex})
IMP memory dump	1036 ($40C_{hex}$)	219
DP memory dump	1036 ($40C_{hex}$)	220
Instrument parameters (sspin boundaries)	148 (94_{hex})	221
Instrument parameter changes	15 (F_{hex}), 47 ($2F_{hex}$) or 94 ($5E_{hex}$)	222
Sector 0 direct events data	1032 (408_{hex})	233 ($E9_{hex}$)


POLAR TIDE/PSI
08/16/97 22:59 to 08/28/97 09:20
log(Energy Flux)
applied RPA voltage
hrs since asc.node
apogee
Mon Feb 23 08:08:28 1998


POLAR TIDE/PSI
08/16/97 22:59 to 08/28/97 09:20
log(Energy Flux)
Spin Angle (deg)
hrs since asc.node
apogee
Mon Feb 23 08:08:40 1998